June to November than during the other months of the year. This includes the time when the big floods come down the San Juan and Condoto Rivers, which may be expected during the months of September to November, and much less frequently during the other months. What dry season there is will come from December to May, although it can not by any means be called dry.

In regard to the rainfall during the day, the greatest part of it falls from 7 to 9 o'clock in the morning and from 5 to 7 in the evening. If it were otherwise, it would be very hard to get any outside work done at all, but there are really more sunshiny days than the record of rainfall would lead one to suppose.

It is rather uncommon for rain to continue falling all day long and if these days were kept track of, I think that it would be found that the most of them occur during the months of heaviest rainfall from June to November. For this reason this time of the year has been called the wet season, and from December to May the dry season, but the rain gage does not bear this out; as, for instance, the second highest monthly rainfall on record, 39.15 inches, occurred in April.

The native way of naming the seasons is very simple and quite flexible; when a few consecutive days are rainy they say it is winter, and when four or five days have been bright and sunshiny they call it summer, no matter what time of the year it may happen to be.

Commenting on the large amount of precipitation during the night hours, Mr. Westlake states:

With regard to the preponderance of precipitation during the night this is a feature of the climate which I have heard commented upon by the half-dozen or more engineers whom we have sent to Colombia since 1912. In fact this feature of the climate of the Choco region was noted and commented upon as far back as 1854 in an article by John C. Trautwine (author of the well-known engineering handbook and one of the builders of the Panama Railroad) in a paper entitled "Rough Notes of an Exploration for an Inter-Oceanic Canal Route by Way of the Rivers Atrato and San Juan, in New Granada, South America, see journal of the Franklin Institute, March to October, 1854."

The only records of relative humidity are those at noon covering parts of the years 1917 to 1919. No data appear for August or September of any of those years. Interpolation of values for these months gives the unusually high value of 82 per cent at noon for the annual mean. The extremes of the monthly means are 86 per cent in February and 78 per cent in October.

C. E. P. BROOKS ON VARIATIONS OF PRESSURE FROM MONTH TO MONTH IN THE REGION OF THE BRITISH ISLES [1]

551.54 (41)

By A. J. HENRY

In this study the author has used the data of monthl deviations from normal pressure for the stations published in *Réseau Mondial* to trace the shifting in latitude and longitude from month to month of the centers of greatest deviation in the region of the British Isles. Only the pressure deviations were dealt with, since those of temperature and precipitation can be explained in terms of the pressure.

The monthly charts afforded little insight into the pressure distributions which were responsible for them; hence it became necessary to examine the daily weather charts for the months considered.

In the beginning the progressive movement of these centers was studied by constructing a series of overlapping 30-day charts March 1 to 30, March 2 to 31, and so on. These charts very clearly showed the gradual movement in a northeasterly direction of the areas of excess or deficit. The construction of 30-day overlapping charts being too laborious, at the suggestion of Dr. George C. Simpson, a shorter method was adopted.

In this method the area covered was that between 30° and 70° north latitude and 70° west to 80° east longitude and only deviations of at least ±5 mb. were considered. When deviations of that amount occurred in two successive months a barbed line was drawn connecting the position of the center during the first month with its position in the second month.

If these centers in successive months were as a rule quite independent of each other, there would be no reason why these arrows should be directed toward one point of the compass rather than another. If, on the other hand, the centers in successive months really indicate two successive positions of the same center, and if there is a tendency for centers to move in one direction rather than in another, the majority of the arrows should point in this direction. The investigation was carried out on three separate series of charts, which between them cover a period of 41 years:

(*a*) A series of monthly charts of pressure deviations over the northern hemisphere covering the years 1873 to 1900.

(*b*) Working charts of deviations of pressure over the globe for the period January, 1910, to April, 1919, prepared in connection with the *Réseau Mondial*.

(*c*) A series of rough working charts of the deviations of pressure over North America, the North Atlantic, western and central Europe, covering the period June, 1922, to October, 1925, prepared in connection with various investigations into current weather.

The *Réseau Mondial* charts were the first set to be dealt with, and it was quickly evident that the movements of the centers in the southern half of the area were very largely from west to east, while in the northern half there were a considerable number of instances in which the movements were apparently from east to west. The work was accordingly repeated, the pairs of months being separated into two classes, the first class including those in which the position of the center during the first month was north of 55° N., while the second class included those in which the position of the center during the first month was south of 55° N. The results of the investigation are shown in Table I (not reproduced). * * *

From Table I we see that between 70° and 55° N. 60 centers of excess gave an apparent movement to the eastward compared with 35 to the westward, and 60 centers of deficit showed a movement to the eastward compared with 49 to the westward. Between 55° and 30° N. 41 centers of excess showed a movement to the eastward compared with 15 to the westward, and 23 centers of deficit showed a movement to the eastward compared with 16 to the westward. In all four groups the easterly movement predominated, although to a much greater extent with centers of excess than with centers of deficit.

The predominance of apparent easterly movement holds in all four seasons, though it is greatest in summer. We find that for each 10 centers of pressure deviation giving apparent westward movement in any one season the number of centers giving an apparent movement to the eastward is: Winter 12, spring 17, summer 21, autumn 16. Many of the instances of apparent movement to the westward are due to the happening that a center of deviation which was shown in the chart for one month had by the following month either moved eastward out of the area or had decreased to an intensity of less than 5 mb., while at the same time a new center of deviation had appeared in the west of the chart. It appears in fact that the month is too big a unit; if the charts had been drawn for each 10 or 15 days, the predominance of apparent easterly movement would have been much greater.

Tracks of centers of excess and deficit were constructed and published. These followed more or less regular courses, somewhat analogous to the paths of cyclones that apparently circle the north pole. The centers of excess show a tendency to move from Alaska southeastward to the center of the United States, thence eastward to a position between Bermuda and Nova Scotia, continuing in that direction to the Azores, thence usually northeastward to the British Isles or across them to Scandinavia, and finally again eastward into northern Russia or the Kara Sea, the whole journey taking about six months, though no single center was found that persisted long enough to move from Alaska to Russia.

[1] Quarterly Journal of the Royal Meteorological Soc. 52: 263-276.

The average life of a center was found to be only about 3 months and a certain number appeared suddenly one month and could not be traced the next.

The movement as above indicated conforms rather closely with that of anticyclones that cross the north American Continent.

The paths of centers of deficit were found to be less regular than those of excess, North America being almost free from centers of deficit amounting to the limit set in the study. This agrees with the experience of the present writer, who is of opinion, that the explanation is to be found in the dispersion of cyclones which obtains in North America. Mr. Brooks notes that a number of centers originate in the neighborhood of Newfoundland and move in an easterly direction. This also is in conformity with experience on this side of the Atlantic; I may offer the suggestion, however, that the explanation of the origin in the location named, may be found in the very marked increase in energy of many cyclones that pass from the continent to the ocean over the Canadian Maritime Provinces. The pronounced contrast in air and water temperatures encountered in this region may be a factor in producing the sudden increase in energy and the associated low levels of pressure in cyclones that traverse that region.

Finally the author discusses the use of the paths of excess and deficit in their relation to forecasting the probable deviation from the normal of the monthly pressure one month in advance. He says:

> The study of the tracks of centers of excess and centers of deficit suggests a possible method of forecasting the deviation of pressure from normal for one month from a consideration of the distribution during the preceding month by methods similar to those employed in daily forecasting. Since the life history of a monthly "center" does not occupy anything like so many months as there are days in the life history of an ordinary anticyclone or depression, and the monthly tracks, especially of centers of deficit, are even less regular than the day to day tracks of depressions, the process evidently requires a gread deal of care.
>
> In order to estimate the chances of success in a forecast based only on the movements of centers of excess or deficit, Table 3 has been prepared, showing for each season for a number of areas the numbers of centers which (a) originated suddenly in the area or (b) moved into the area from some other region.
>
> A center which moves into any region from outside, so long as it follows the normal track, would give a generally successful forecast; a center which appears in that region with no previous sign of its existence would give a failure. Hence as a preliminary test of the possibilities of forecasts deduced from the tracks, unaided by any other consideration, we may take (b) as successes and (a) as failures. This gives us the following frequency of successes and failures in Europe (Table 4):

TABLE 4.—*Probable result of monthly forecasts for Europe*

	Successes	Failures
December to February	6	5
March to May	15	1
June to August	5	4
September to November	5	2

> From this table we should expect a reasonable amount of success in spring but doubtful results during other seasons. Evidently some improvement in the methods is required before long-range forecasting from the movements of centers of pressure deviation can promise success. Forecasts based on the movements of centers of excess in general offer greater chances of success than those based on the movements of centers of deficit.

PART 2 OF GREGG'S AEROLOGICAL SURVEY OF THE UNITED STATES

RESULTS OF OBSERVATIONS BY MEANS OF PILOT BALLOONS

551.5 : 629.132.1 (73)

By BURTON M. VARNEY

Like Part 1 of the Survey, Part 2 has been issued as a SUPPLEMENT to the MONTHLY WEATHER REVIEW, No. 26,[1] Part 1 having been SUPPLEMENT No. 20, dealing with "Results of Observations by Means of Kites."

The present SUPPLEMENT deals necessarily with free-air conditions over the country east of the Rockies only, sufficient data not having as yet been accumulated from the remainder. The main purpose of the paper being to supply data in a form that will be useful to aviation in such matters as the planning of flight schedules, Mr. Gregg presents extensive tables showing frequencies of different wind directions and speeds at flying levels, in addition to the abundant data now available for altitudes above those at which flying is commonly done. The information is classified under nine regional sections, an excellent arrangement which lends itself to the study of that portion of the country in which one may be interested. The free use of graphs and charts makes it possible for those less concerned with statistical details to form a satisfactory picture of the average free-air conditions over the United States.

Very briefly summarizing the salient points of the work, we have the following:

Average wind velocities in the free air.—At the surface these are highest as a rule in spring, while those of autumn are closely like the average annual velocities. For the country as a whole wind velocities approximately double from the surface to 500 m., which is about the level at which the gradient wind is reached. The increase is often much greater, especially at night and in winter, and it is least in the daytime and in summer. In the next thousand meters, little change of velocity, great irregularity, and often a decrease of velocity is the rule. Thence to the base of the stratosphere there is a gradual increase, except at southern stations in summer, where frequently there is almost no wind at any height within the range of observations.

Diurnal variation in wind velocities.—The author rightly takes pains to emphasize the fact of the reversal of phase which takes place between the ground and a short distance above it. The surface layer of air, characterized by the well-known afternoon maximum and early morning minimum of wind velocity, is exceedingly thin, only 50 to 100 meters, and above that the diurnal change of velocity is exactly reversed. At the surface the diurnal range is but 1 to 2 m. p. s.; at the level of the gradient wind it averages 2 to 4 m. p. s., but above that critical level it decreases to practical extinction at 1,500 to 2,000 meters.

Frequency of free-air winds of different velocities.—Experience has shown that it is the winds of 10 m. p. s. or more which must be reckoned with in planning workable flight schedules. It is therefore of interest to note that—

> At the surface the frequency of winds of 10 m. p. s. or more is very small, averaging from 5 to 10 per cent, with a maximum as a rule in spring and winter. There is no very marked variation in different parts of the country.
>
> A decided increase occurs immediately above the surface * * * At "ordinary flying levels"—i. e., 500 to 1,000 meters—winds

[1] This SUPPLEMENT is on sale by the Superintendent of Documents at 20 cents per copy.